Title: LIQUID APPLICATION SYSTEM FOR CENTER PIVOT IRRIGATION SYSTEM

Abstract: Low flow liquid application system for center pivot irrigation systems, based on the installation of micro-micro-sprinklers with variable spacing between them, to evaluate case by case. The size and the water flow of each micro-micro-sprinkler can be constant, its location being defined so that any micro-micro-sprinkler corresponds an equal ground area. The micro-micro-sprinklers are installed in a system of two feeding and distribution pipes, with filtering and pressure regulation systems, the micro-micro-sprinklers having eventually an individual flow regulation system, depending on the size of the pivot and the ground topographic conditions. The distribution pipe can be installed at a variable high to the ground, for fitting to the existing crops, and the chemical products application can be restricted isolating parts of the distribution pipe if necessary.
DESCRIPTION

"LIQUID APPLICATION SYSTEM FOR CENTER PIVOT IRRIGATION SYSTEMS"

1. BACKGROUND OF THE INVENTION

The present invention refers to a Low flow liquid application system for center pivot irrigation systems, for applications requiring low volumes of water, as chemical treatments.

The invention consists of adapting to the pivot independent pipes with micro-sprinklers having different distances between them, according to calculation to make case the case to obtain the correct distribution and application uniformity.

The micro-sprinklers are installed with growing spacing, from the pivot's end to its center, and may have constant or variable values of water flow.

When this space becomes theoretical bigger than the maximum allowed, attending to the need to keep a good coverage of each micro-sprinkler's debit, it will be installed a temporization
system, reducing the effective flow and allowing the reduction of that distances.

2. STATE-OF-THE-ART

Actually this kind of applications is made with aerial means, with tractor-mounted micro-sprinklers, directly trough the pivot’s irrigation water or by means of other pivot-mounted systems.

The applications by aerial means are being restricted due to its costs and associated ecological risks.

The tractor-mounted micro-sprinklers applications are very limited by the soil conditions, becoming many times impossible, and produce a partial destruction of the installed crops.

The direct applications through the pivot’s irrigation water requires the use of very high amounts of water, that are not desired in many seasons and incompatible with many products because of the very high resulting dissolution degree for them. Meanwhile many of these products are chemically aggressive for the pivot’s structure, reducing its useful life.

Other pivot-mounted systems are very expensive and not very trustful, in terms of maintenance or efficiency.
They are usually based in micro-sprinklers installed at fixed distances, looking to achieving the distribution uniformity by an increase of the flow provided for each spray, as they are even further from the center of the system.

This flow control is very complex especially in low flow systems; it is conditioned by the difficulty to find proper equipment with the required rigor, and has not yet been properly solved.

Among the systems of the previous technique we'll next refer some documents however not based on the growing spacing between sprays, from the pivot’s end to its center. Among them, we refer patent FR2659829, US5246164, and DE10154470

Patent FR2659829 refers to a rotating circular micro-sprinkler system for watering crops and applying pesticides. The system consists in a frame in sections on wheeled supports, rotating about a central fixed tower. The frame carries a main feed pipe, which is connected to the spray bar by a series of vertical branches one for each section, incorporating a pressure regulator and electrically operated-valve. Each valve is linked in parallel with the drive motor of the corresponding section’s wheeled support so that the valve closes and shuts off the feed to the spray bar every time the micro-sprinkler stops. A horizontal cable, to which clips connect it at intervals,
supports the spray bar and it has tensioners at its ends to maintain its horizontal position.

Patent US5246164 refers to an irrigation system having a number of micro-sprinklers in a fixed array each other, which are pivotally rotatable about a central tower or linearly movable along the length of a field, on a wheel line system or in a fixed solid lattice grid of a micro-sprinkler pipe. A solenoid-operated valve from a control module that is connected to a data acquisition and control unit, which activates or deactivates each individual micro-sprinkler head, independently controls each micro-sprinkler. A microprocessor receives data from micro-sprinkler line position sensors, ground speed sensors and micro-sprinkler line pressure sensors, and is programmed to determine the current position of each individual micro-sprinkler. The microprocessor generates maps from the field data or digital images, and the map positions, corresponding to current micro-sprinkler positions, are tested to determine water or chemical application requirements. The test data is then input by the microprocessor to the data acquisition and control system, which in turn sends signals to the micro-sprinkler control modules.

Patent DE10154470 refers to an irrigation device, especially for irrigating agricultural areas, that comprises a chassis supporting an extension arm protruding an equal distance over both sides of the chassis and provided at each end with a micro-
sprinkler coupled to a water supply line. Each micro-sprinkler has at least two discharge nozzles arranged the same distance from the axis of rotation of the micro-sprinkler and the same angle. The discharge nozzles are directed in a tangential position to the axis of rotation. The position of each discharge nozzle is variable. Each discharge nozzle is fixed via a flange on a micro-sprinkler head rotating about the axis of rotation. This irrigation device is used for the irrigation of agricultural areas. The irrigation device has a relatively simple construction guaranteeing ecological and economical irrigation.

As we can see none of the referred documents anticipates the object of this invention. In fact none of that documents refers a growing spacing between the sprays, which will allow the use of a constant flow at any spray.

3. DESCRIPTION OF DRAWINGS

The following description is based on the annex figures that, without any limitative feature, represent

Drawing n° 1: schematically, a center pivot and the system’s installation way for the Low flow liquid application system.
Drawing n° 2: detail of the linking between the system's pipes and the pivot's vertical pipe.

Drawing n° 3: detail of the positioning of the pressure regulation systems, the pressure indicator and the manual and automatic valves.

4. DESCRIPTION OF THE INVENTION

The base of the invention is the use of low flow and cost sprays (1) installed on a distribution pipe (2) suspended to the pivot at variable distances from each other (3), to compute for each pivot.

These sprays (1) can be of uniform flow, helping his choice and his installation. If required by the ground topography, they may include flow compensation system, so that the flow is constant regardless the inlet pressures.

The distribution pipe (2) is fed in various points from the main feeding pipe (4), disposing at that points pressure regulation systems (5), pressure indicators (6) and manual or automatic valves (7) allowing to intersect the distribution pipe when the application in some parts is not desired.
The feeding pipe (4) is connected to the pivot's vertical pipe (8), from where receives the water, after proper manual or automatic filtering (9).

The inlet of chemical products is made after this filter by means of a dosing pump (10), being required the installation of an anti return valve (11) avoiding the chemical flow upwards.

At the distribution pipe's sections where the spray's working must be time controlled, acts a solenoid valve (12) controlled by a timer relays (13) installed for instance at the pivot's control panel (14).

So the system uses the pivot's electrical and water supplies, as most of its existing security systems, being installed a valve (15) avoiding water entrance to the pivot.

The pivot’s pumping system can be used to feed this system if it is installed a pressure control system as a reducing pressure valve or a flow return by-pass, or other pump control system as a motor speed controller.

It may also be installed a specific pump group for this low flow system.
The distribution pipe can be installed at a fixed or variable high to the ground, adapting to the existing crops, and the chemical products application can be restricted separating same of its sections, allowing cost and ecological risk reductions.
CLAIMS

1. Low flow liquid application system for center pivot irrigation systems allowing the use of very low flow values, based on the installation of two pivot's suspended pipes, one for liquid feeding and the other for its distribution, with filtering and pressure control systems, being its water feeding the pivot's feeding pipe or other, suspended at variable heights from the ground for adapting to the crop's conditions, being the products application optionally restricted, manual or automatically, to chosen sections of the distribution pipe, characterized for using variable spacing between the liquid distribution sprays, growing from the end of the pivot to its center, to calculate case by case, what allows that each spray have equal dimensions and flow values, helping the system's dimensioning, installation and maintenance, being the spray's locations along the system defined by the rule that to each one corresponds an constant area of the field.

2. Low flow liquid application system for center pivot irrigation systems according with the first claim characterized for, when the theoretical spacing between sprays is excessive from de pint of view of the required distribution uniformity, the use of a spray's temporization system allowing to reduce the theoretical spacing.
3. Low flow liquid application system for center pivot irrigation systems according with the previous claims characterized for the use of flow regulated sprays, with the same flow regardless the inlet pressure, whenever the field topography conditions requires.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

A01G25/09

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

A01G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the International search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
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<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<tbody>
<tr>
<td>A</td>
<td>US 5 779 163 A (GUNTER ET AL) 14 July 1998 (1998-07-14) claims 1-3; figures</td>
<td>1-3</td>
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<tr>
<td>A</td>
<td>FR 2 659 829 A (URA RIEGO SA) 27 September 1991 (1991-09-27) cited in the application claim 1; figures</td>
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<td>A</td>
<td>US 5 246 164 A (MCCANN ET AL) 21 September 1993 (1993-09-21) cited in the application claim 1; figures</td>
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<td>A</td>
<td>US 3 669 353 A (RICHARD E. HANSON ET AL) 13 June 1972 (1972-06-13) abstract; claims; figures</td>
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Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"1" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

Date of the actual completion of the international search

13 February 2006

Date of mailing of the international search report

24/02/2006

Name and mailing address of the ISA

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<table>
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<th>Publication date</th>
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<tr>
<td>FR 2659829</td>
<td>27-09-1991</td>
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<td>13-06-1972</td>
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